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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : H04N 5/913 — A1

(11) International Publication Number: **WO 00/13413**

(43) International Publication Date: 9 March 2000 (09.03.00)

(21) International Application Number: PCT/US99/20010

(22) International Filing Date: 1 September 1999 (01.09.99)

(30) Priority Data:
60/098,804 2 September 1998 (02.09.98) US

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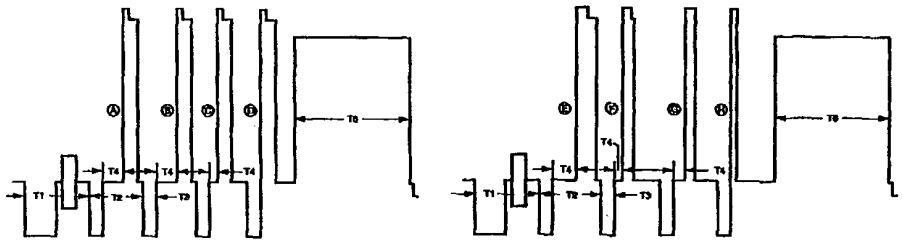
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published

With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: METHOD AND APPARATUS TO SYNTHESIZE AND DEFEAT VIDEO COPY PROTECTION SIGNALS



(57) Abstract

A method and apparatus for defeating copy protection signals in a video signal, and also for providing copy protection signals for a video signal, is disclosed. The defeat technique generally utilizes a particular pulse position shifting, modulation, etc., of AGC, normal sync and/or pseudo sync pulses to increase the separation between the pulses. Various embodiments are disclosed including selective shifting of the relative positions of either the sync/pseudo sync or AGC pulses, trimming portions of the sync/pseudo sync and/or the AGC pulses and narrowing of either the sync/pseudo sync and/or the AGC pulses, all to provide the selective position separation between the sync/pseudo sync and AGC pulses. The copy protection technique includes various embodiments for dynamically varying the sync/pseudo sync and AGC pulse separation by applying a modulation of the above position shifting, trimming and/or narrowing techniques over selected time periods to cycle from the copy protection condition to the copy protection defeat condition, back to the copy protection condition.

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METHOD AND APPARATUS TO SYNTHESIZE AND DEFEAT VIDEO COPY PROTECTION SIGNALS

CROSS REFERENCE TO RELATED APPLICATIONS

This invention is related to commonly owned U.S. Patent No. 4,631,603 entitled "METHOD AND APPARATUS FOR PROCESSING A VIDEO SIGNAL SO AS TO BE ABLE TO PROHIBIT THE MAKING OF ACCEPTABLE VIDEO TAPE RECORDINGS THEREOF" which issued on December 12, 1986; to U.S. Patent No. 4,695,901 entitled "METHOD AND APPARATUS FOR REMOVING PSEUDO-SYNC PULSES AND/OR AGC PULSES FROM A VIDEO SIGNAL" which issued on September 22, 1987; to U.S. Patent No. 4,907,093 for METHOD AND APPARATUS FOR PREVENTING THE COPYING OF A VIDEO PROGRAM" which issued March 6, 1990; to U.S. Patent No. 4,819,098 for "METHOD AND APPARATUS FOR CLUSTERING MODIFICATIONS MADE TO A VIDEO SIGNAL TO INHIBIT THE MAKING OF ACCEPTABLE VIDEO TAPE RECORDINGS" which issued on April 4, 1989; to U.S. Patent No. 5,157,510 for "METHOD AND APPARATUS FOR DISABLING ANTI-COPY PROTECTION SYSTEM IN VIDEO SIGNALS USING PULSE NARROWING which issued on October 20, 1992; to U.S. Patent No. 5,194,965 for "METHOD AND APPARATUS FOR DISABLING ANTI-COPY PROTECTION SYSTEM IN VIDEO SIGNALS" issued on March 16, 1993; to U.S. Patent No. 5,625,691 for "METHOD AND APPARATUS TO DEFEAT CERTAIN COPY PROTECTION PULSES WITHIN A VIDEO SIGNAL" issued on April 29, 1997; to U.S. Patent No. 5,633,927 for "VIDEO COPY PROTECTION PROCESS ENHANCEMENT TO INTRODUCE HORIZONTAL AND VERTICAL PICTURE DISTORTIONS" issued on May 27, 1997; to U.S. Patent No. 5,748,733 for "METHOD AND APPARATUS TO

REDUCE EFFECTS OF CERTAIN COPY PROTECTION PULSES WITHIN A VIDEO SIGNAL" issued on May 5, 1998; to U.S. Patent No. 5,661,801 for "METHOD AND APPARATUS FOR STABILIZING AND BRIGHTENING PRERECORDED TV SIGNALS ENCODED WITH COPY PROTECTION" issued on August 26, 1997; to U.S. Patent No. 4,336,554 for "CODE SIGNAL BLANKING APPARATUS" issued on June 22, 1982 and to U.S. Patent No. 5,583,936 for "VIDEO COPY PROTECTION PROCESS ENHANCEMENT TO INTRODUCE HORIZONTAL AND VERTICAL PICTURE DISTORTIONS" issued on December 10, 1996. All of the above are incorporated by reference.

Also related is U.S. Patent No. 4,163,253 for "METHOD APPARATUS FOR MODIFYING A VIDEO SIGNAL TO PREVENT UNAUTHORIZED RECORDING AND REPRODUCTION THEREOF" issued on July 31, 1979.

BACKGROUND OF INVENTION

Field of the Invention

The field of the invention is in the mechanisms and/or methods for defeating, removing, or reducing the effects of the video copy protection signals. These mechanisms are also used to synthesize and improve the performance of a video copy protection signal.

Description of the Prior Art

The Hollywood movie industry is very concerned about the unauthorized copying of movies and programs. As an example, on September 17, 1997 Jack Valenti, President and Chief Executive Office of the Motion Picture Association of America stated "If you can't protect what you own - You don't own anything." The patent by Ryan, 4,631,603, incorporated by reference, discloses a way to process an ordinary program video source to

have copy protection. The copy protected video is viewable on a TV set but it produces a recording lacking any entertainment value. That is, the video programs that are not recordable suffer from artifacts ranging from low contrast to synchronizing problems. The '603 patent describes a method for "confusing" or causing misoperation of the AGC system in a videocassette recorder while not causing a black depression problem in a television receiver displaying the copy protected signal.

A Polish Patent Application (PL 304477 ('477)) by Tomasz Urbaniec entitled "Method and Device for Protecting Videophonic Recordings Against Authorized Copying" filed July 28, 1994, hereby incorporated by reference, discloses a variation of the '603 patent by Ryan. Figure 1a of the '603 patent describes the waveform of the copy protected video signal as disclosed by Ryan and is replicated herein as Figure 1a. Figure 4 of the Urbaniec patent '477 describes the comparative waveform as disclosed by Urbaniec, which is replicated herein as Figure 1(b).

As is well known in the art, the videocassette system has a limited luminance frequency response, less than 2 MHz. A signal as described by Ryan recorded on a videocassette duplicating recorder with the AGC turned off (to avoid the effects of copy protection) will produce a video signal with pulse shapes modified by the limited frequency response of the duplicating recorder. Since there is no gap between the pseudo sync pulses and the AGC pulses of Ryan, the AGC system of a home duplicating recorder will respond to the combination of the pseudo sync pulses and the AGC pulses.

The limited bandwidth of the recording VCR responds slightly differently to the combination of pseudo-sync and AGC pulses separated by a time gap of 0.5 μseconds to 2.0 μseconds. If the time gap is as low as 0.5 μseconds, the limited bandwidth of the recording videocassette recorder distorts the time gap to effectively remove it and the

effectiveness of the copy protection is essentially the same as that achieved by Ryan. As the gap widens, the effectiveness of the copy protection is reduced or removed.

To defeat the copy protection process, there are a number of known ways such as attenuating, blanking, narrowing, level shifting, modifying and/or clipping the copy protection pulses as described in patents 4,695,901 ('901), 4,336,554 ('554), 5,157,510 ('510), 5,194,965 ('965), 5,583,936 ('936), 5,633,927 ('927), 5,748,733 ('733) and 5,661,801 ('801) cited above and hereby incorporated by reference.

In the patents mentioned above, the AGC and/or sync or pseudo sync pulses (see 4,695,901) are changed in amplitude, changed in level relative to normal sync pulses, and/or changed in pulse width, so as to allow a satisfactory recording.

In particular, Patent 5,194,965 and 5,157,510 disclose narrowing of the AGC and/or pseudo sync pulses so that the record VCR does not sense these narrowed added pulses and thus, makes a satisfactory copy.

SUMMARY OF THE INVENTION

To defeat the anti-copy signal, the present invention discloses a method and apparatus utilizing pulse position and pulse width modulation of the AGC and/or sync or pseudo sync pulses. The invention also discloses the insertion of a sufficiently wide time gap between the AGC and/or pseudo sync pulses such that the record VCR will respond to or sense the sync or pseudo sync pulses but still will allow for a recordable copy.

The copy protection defeating mechanisms of this invention can also be used in combination with any of the defeat inventions mentioned above. For example, to defeat the copy protection process, one can shift (delay) the AGC pulse by about 1.5 μseconds away from the preceding pseudo sync pulse and then trim the trailing edge of the preceding pseudo sync pulse by 0.6 μsecond. Thus a gap of about 2.1 μseconds exists

between the trailing edge of the trimmed pseudo sync pulse and the leading edge of the delayed AGC pulse. If this gap is, for example, near blanking level for 2.1 μseconds, then the VCR will sample the voltage in the gap instead of the added AGC pulses for its AGC amplifier. By sampling this gap voltage near blanking level, the copy protection signal is then nullified. Alternatively, the gap voltage level may be set above or below blanking level. It is important to note that by simply delaying or shifting the position of the leading edge of the AGC pulse relative to the trailing edge of the pseudo sync pulse, the gap between the pseudo sync pulses and the AGC pulses will nullify or partially nullify the effects of the AGC copy protection signal. It is also possible to create this gap in other ways such as moving the trailing edge of pseudo sync pulse away from the leading edge of the upcoming AGC pulse, or some combination of moving the position of both the AGC pulse and pseudo sync pulse to form a gap that would defeat the copy protection process. Typical gap durations of 1.5 μseconds or more have proved effective in defeating the copy protection signal. Compounding the narrowing of the pseudo sync pulses and/or AGC pulses with this gap further enhances defeating the copy protection signal.

It should be noted that the defeat method as described above can be varied and then used as a copy protection signal. By dynamically varying the gap from zero to greater than 1.5 μseconds between the trailing edge of the pseudo sync pulse relative to the leading edge of the upcoming AGC pulse, a new copy protection signal is made to effectively mimic the Ryan '603 patent with amplitude modulated AGC pulses. By varying the gap via position modulation of the pseudo sync pulses relative to the AGC pulse or vice versa, or dynamically narrowing or changing the pulse width of the added pulses (AGC pulse and/or sync or pseudo sync pulse), an easier copy protection implementation is possible in the digital domain and/or analog domain. Today's digital domain is the format of choice for implementing copy protection in cable systems and the

like (i.e. digital versatile disc players). The range of pulse widths can be for example, between about 50% to 100% of the normal pulse widths (i.e. the pseudo sync pulse normal widths are about 2.3 μseconds and the AGC normal widths are about 2.3 μseconds to 3 μseconds depending on how many added pulses are in a television (TV) line).

In general the copy protection process of the invention may start having the added pulse pairs as for example in Figure 2(a) of Ryan '603 patent, where the AGC pulse and/or pseudo sync pulse are position separated relative to time. If the gap due to position separation is insufficient to "turn off" the copy protection process (i.e. position modulation amounts to only 1.0 μsecond of gap), then the AGC pulse and/or pseudo sync pulse can be narrowed as a function of time to increase the gap sufficiently (i.e. slowly trim or narrow the AGC pulse and/or pseudo sync pulse by about 0.35 μsecond each, which would add another 0.7 μsecond to the 1.0 μsecond gap for a increased gap duration of 1.7 μseconds). After the gap has been extended as to "defeat" or turn off the copy protection signal, then the new copy protection signal is reactivated by reducing the separation (for example, to zero) between the AGC pulse and pseudo sync pulse and by restoring the pulse widths of the (trimmed or narrowed) AGC pulses and/or pseudo sync pulse to their full normal pulse widths.

The method of using relative position modulation between the sync and AGC pulses for defeating and/or synthesizing a copy protection signal can be applied to the copy protection pulses within or around a horizontal blanking interval. The method can also be combined with narrowing any portion of the added pulses.

In order to produce a further effective copy protection signal, a variation of the 4,631,603 patent has been developed. To this end, the AGC pulses also are amplitude modulated from full amplitude to zero and vice versa over the period of for example about 20 to 30 seconds. As a result, the illegal copy will have constantly changing brightness

levels. This causes more annoyance when compared to a constant dim picture (when the AGC pulses are static and at full amplitude).

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1a illustrates a the basic anticopy process consisting of AGC and pseudo sync pulses;

Figure 1b illustrates the Urbaniec modification to the basic anticopy process consisting of AGC and pseudo sync pulses;

Figure 2 illustrates various ways to position shift the AGC pulse to defeat the copy protection signal. Figure 2 also shows a way of dynamically shifting the position of the AGC pulse to provide the copy protection process of the invention;

Figure 3 illustrates a combination of position shifting and narrowing (trimming) the AGC pulses to defeat the copy protection signal. Figure 3 also shows a way of dynamically shifting the position and then narrowing the AGC pulses in accordance with the copy protection process of the invention;

Figure 4 illustrates various ways to shift the relative position between AGC pulses and pseudo sync pulses while narrowing pseudo sync and/or AGC pulses to defeat the copy protection signal. If the positional shifting and narrowing of AGC pulses and/or pseudo sync pulses is done from zero to maximum, then this technique can be used as the copy protection signal of the invention;

Figure 5 illustrates a block diagram of an apparatus for defeating a copy protection signal by delaying the AGC pulses;

Figures 5a to 5e illustrate the waveforms generated at various points in the circuit of Figure 5;

Figure 6 illustrates an apparatus for defeating a copy protection process by inserting a time gap between the pseudo sync pulses and the AGC pulses;

Figures 6a to 6E illustrate several waveforms related or generated by the circuit of Figure 6 given typical copy protection signals as an input;

Figure 7 illustrates copy protection apparatus of the invention that generates a dynamically variable time gap (around blanking level) between the trailing edge of pseudo sync pulses and the leading edge of AGC pulses;

Figures 7a to 7e illustrate the relevant waveforms that are generated at various points in the circuit of Figure 7;

Figures 8a and 8b illustrate position delay or modulation of the raised back porches as mentioned in '098 which can be used as a defeat process or as a copy protection signal. By varying the gap between the trailing edge of (horizontal) normal sync pulses and their raised back porch AGC pulses, the VCR will respond to these as if the raised back porch AGC pulses are being amplitude modulated up and down, which results in yet another dynamic copy protection process of the invention;

Figure 9a illustrates a prior art copy protection signal. Figure 9b illustrates a defeating or modifying method by reversing at least portions of the pseudo sync and/or AGC pulses. Figure 9c illustrates another method for defeating or modifying the original process (Figure 9a for example) by phase shifting (i.e., inverting) portions of the pseudo syncs and/or AGC pulses;

Figure 10 is a block diagram illustrating a circuit for reversing at least portions of the pseudo sync and/or AGC pulses by way of a memory circuit; and

Figure 11 is a block diagram illustrating a circuit for inverting or phase shifting portions of the pseudo syncs and/or AGC pulses by way of an inverting or phase shifting

amplifier along with a switching or dissolving amplifier. An optional level shifting and/or attenuating circuit is also shown in Figure 11.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As previously discussed, Figures 1a and 1b illustrate prior art copy protection and copy protection defeating signals, respectively.

Figure 2 illustrates various waveforms corresponding to ways that AGC pulses can be delayed to provide the copy protection defeating technique of the invention. First, the waveform D in Figure 2 illustrates the AGC pulse and pseudo sync pulse at the normal position previously shown in Figure 1a which causes copy protection. Waveforms A to C show various delays or gaps between the trailing edge of pseudo sync pulse and the leading edge of the respective AGC pulse. Waveforms A and B are effective in turning off the copy protection signal while waveform C causes partial reduction or turn off of the copy protection signal. For effective defeat of the copy protection signal it follows that waveforms A and B are preferable.

For a new copy protection signal that is dynamically varied from on to off, one technique of the invention starts for example, with several seconds of the waveform D of Figure 2 (copy protection on) then transitions to the waveform C of Figure 2 (copy protection partially on) and then transitions to the waveform B of the Figure 2 (copy protection turned off). The gap, or separation T4, in Figure 2 is preferably continuously or discretely changing from zero to greater than about 1.5 μseconds. Waveform A is used to turn copy protection off.

In Figure 2 (as well as Figures 3, 4) the time interval T1 defines the normal sync to the first pseudo sync pulse period, T2 defines the repetition rate of added pseudo sync

pulses, T3 defines the pseudo sync pulses' width and T4 defines the gap duration. T6 designates the width of a white reference pulse which may be included as an option.

Figure 3 illustrates a variation of the embodiment of Figure 2 with AGC pulse narrowing, although the pseudo sync pulses can be narrowed as well. In the waveform H of Figure 3, the pulse resembles a narrowed AGC pulse in the patents '510 and '965 of previous mention. While waveform H of Figure 3 can be used for defeating copy protection signals, it can again also be used as part of a copy protection signal. The waveform D of Figure 2 represents a normal copy protection signal which can transition to the waveform H of Figure 3, a signal with a narrowed AGC pulse, and then transition to waveform F of Figure 3, a signal with a gap and narrowed AGC pulse. Finally the copy protection signal can be turned off by a transition to the waveform G of Figure 3, where the gap is larger with a narrowed AGC pulse. Waveform E of Figure 3 is equivalent to waveform A of Figure 2 and is used to defeat copy protection.

Figure 4 illustrates pseudo sync pulse narrowing combined with position delay or modulation of varying pulse widths of the AGC pulses to defeat the copy protection process, or form a dynamic copy protection signal.

The waveform D' of Figure 4 illustrates a defeat process not illustrated in the patents of previous mention by Quan et al '510 and '965. In waveform D' of Figure 4 the pseudo sync pulse's trailing edge is advanced to provide a narrowed pseudo sync followed by a delayed AGC pulse leading edge to provide a narrowed AGC pulse. The waveform C' of Figure 4 illustrates a further gap increase in duration between the AGC pulse by position delaying the AGC pulse using an advanced trailing edge to narrow the pseudo sync pulse. The waveform B' of Figure 4 illustrates a combination of position separation between the AGC pulse and the pseudo sync pulse with narrowed AGC and pseudo sync pulse. Thus, the waveform B' can be used as a method to defeat the copy protection

pulses. As may be seen, waveform A' is generally the equivalent of waveforms A and E of Figures 2 and 3, respectively, and also may be used to defeat the effects of copy protection signals.

Alternatively, by employing narrowed pseudo sync pulses and/or AGC pulses that are varied in width, Figure 4 provides a dynamic copy protection signal of the invention based on dynamically changing the gap (separation) and the amount of narrowing on pseudo sync pulses and/or AGC pulses. For example, the embodiment may start with a waveform D as illustrated in Figure 2 to provide the copy protection process, then provide narrowing of the AGC pulses and/or pseudo sync pulses to achieve partial copy protection via the waveform C' in Figure 4, and then transition to a signal such as waveform B' in Figure 4 to turn off the copy protection. The embodiment then reverses the cycle from waveforms B', to C' and back to D to restore the copy protection.

Figure 5 is a block diagram depicting an example of circuitry for defeating the copy protection pulses by delaying the AGC pulses relative to the pseudo sync pulses. To this end, copy protected video is inputted as at (a) to a delay line circuit 50, which delays the input video, and also to a sync separator circuit 52. The output of the sync separator circuit provides horizontal and vertical sync pulses to a timing circuit 54 which in turn outputs pulses at (d) coincident with the video lines containing raised back porch AGC pulses and those with AGC pulses. This output signal, AGCLL, is logic high at least from the leading edge of the AGC pulses of the input video signal to the trailing edge of the AGC pulses which appear at an output (b) of the delay line circuit 50 (delayed input video of about 1.5 μseconds or more). A black clipper circuit 56 coupled to the delay line 50 clips off most or all of the sync pulses. Thus, delayed AGC pulses are supplied at the output (c) of the black clipper circuit. By using an electronic switch 58, with control

signal AGCLL to switch in the delayed AGC pulses, the copy protection pulses' effects are then defeated or reduced at the output (e) of an amplifier 60.

Figures 5a through 5e illustrate the waveforms generated at different locations of Figure 5 and is generally self-explanatory. For example, in Figure 5e, the output has a gap, that is, separation 62, corresponding to gap T4 of Figures 2-4, long enough between the sync pulses and AGC pulses to allow recordable copies of the video signal. It should be noted that Figure 5 is just an illustration of an apparatus for producing position delay of AGC pulses to defeat the copy protection signal. It is also possible to design a position delay equivalently by removing substantially the original copy protection signal or parts of it and then regenerating modified pseudo sync pulses and/or AGC pulses. For instance, the incoming copy protection pulses may be removed and then the pseudo sync pulses inserted in advance of the original pseudo sync pulse, with AGC pulses inserted in delayed relation to the original AGC pulses. Thus a gap voltage is produced between the pseudo sync pulses and AGC pulses that allows for a recordable copy.

Figure 6 is a block diagram depicting circuitry for creating a time gap around blanking level by trimming off (advancing) the trailing edge of sync and delaying the leading edge of the AGC pulse of the copy protection signal, leading to a recordable copy. This "trimming" is a different form of narrowing not illustrated in the U.S. Patent 5,194,965. Copy protected video is fed at (a) to a sync separator 64 to output composite sync including pseudo sync pulses to a one shot (multivibrator) 66. One shot 66 triggers off the leading edge of sync pulses including pseudo sync pulses, and its pulse width can be controlled via a control voltage VC66. The output (b) of one shot 66 is coupled to another one shot 68 whose pulse width is controlled by another control voltage,VC68. The output (b) of one shot 68 is then a pulse coincident with the latter portion of the sync or pseudo sync pulse and the beginning portion of the AGC pulse of the copy protected

input video signal. A sync separator output also is fed to a timing circuit 70 which generates pulses coincident with the copy protection signal within the video lines. The output of the timing circuit 70 and of the one shot 68 are fed to an AND gate 72 to control a switch 74 during the times copy protection pulses are present. The switch 74 receives the copy protected video at (a) and supplies a signal containing a gap voltage between the sync and AGC pulses of copy protection signals, whereby the video signal at an output (e) of an output amplifier 76 allows for a recordable copy. Figure 6 also uses a chroma bandpass filter 78 to generate the gap, but also to reinsert color burst during narrowing of the normal sync and/or raised back porch. As a matter of fact narrowing and/or attenuation and/or level shifting of any kind on the raised back porch AGC pulses and/or its sync signal can result in a recordable copy (see raised back porch AGC signal as in Figure 3 of US Patent 4,819,098 by Ryan).

Figures 6a to 6e show the result of this kind of narrowing. Figure 6a represents a typical copy protection signal consisting of pseudo sync pulses and AGC pulses. Figure 6b shows the narrowed pseudo sync pulses and/or AGC pulses with a gap (voltage) in between. Figure 6c shows a horizontal pulse with a raised back porch AGC pulse in typical fashion of a copy protection signal. Figures 6d and 6e show the result of the apparatus of Figure 6 which narrows the raised back porch AGC pulse (Figure 6d) and/or the horizontal sync pulse (Figure 6e) to allow a recordable copy. Note in Figure 6e the color burst is still present even after narrowing, in the area where burst is normally located.

Figure 7 is a block schematic diagram depicting circuitry for generating a copy protection process of the invention that mimics the amplitude modulation of AGC pulses by position modulation. Program video with or without copy protection is the input video signal supplied at input (a) to a sync separator 80, which in turn outputs horizontal rate pulses. These horizontal rate pulses are coupled to a horizontal locked (triggered)

oscillator 82. The output of this oscillator is preferably but not necessarily locked to the horizontal frequency at a higher frequency (i.e. 4 cycles per half a video line). A one shot (multivibrator) timer circuit 84 defines the positive pulse duration of the horizontal locked oscillator 82. Meanwhile, the sync separator 80 also outputs the horizontal rate pulses to a one shot 86, whose output is coupled to a one shot 88. The latter supplies a gating pulse for the location of pseudo sync pulses in the video line (i.e. 32 μseconds or first half of the video line). The location of the respective video lines that will contain the copy protection pulses is generated by a circuit consisting of a one shot 90, a (525) line counter 92 and an EPROM circuit 94. From the sync separator 80, horizontal pulses are supplied to the one shot 90 whose output is coincident with the beginning of the video line. A frame reset pulse is fed to the 525 line counter 92 (i.e. for NTSC) along with the horizontal rate pulses for the counter's clock. The counter's output is used to address the memory circuit of EPROM 94, which is programmed to output logic high pulses coincident with those video lines that will have the copy protection pulses. The output (b) of an AND gate 96 then comprises "inverted" pseudo sync pulses on selected video lines (i.e., in the vertical blanking interval).

One method for generating position modulated AGC pulses is to induce pulse width modulation on an inverted pseudo sync pulse signal and then trigger off the trailing edge of this pulse width modulated inverted pseudo sync pulse signal to generate AGC pulses. To this end, the output of AND gate 96 triggers a voltage controlled one shot timer 98 on the leading edge of an "inverted" pseudo sync pulse signal. The output (c) of one shot timer 98 is a pulse with a minimum width of the output of AND gate 96, and a maximum pulse width of 1.5 μseconds (or more) than its minimum pulse width. For example if the output of AND gate 96 has a pulse width of 2.3 μseconds, then the output of one shot timer 98 has pulse widths that vary according to voltage control VC1 from 2.3

μseconds to at least 2.3 μsecond +1.5 μseconds or at least 3.8 μseconds. The output of one shot timer 98 is OR'd by an OR gate 100 with the output of AND gate 96 to ensure that the output (d) of OR gate 100 has a minimum width of the "inverted" pseudo sync pulse from the AND gate. The output of the OR gate 100 triggers on the trailing edge to output AGC pulses whose widths can be controlled voltage wise via a voltage control VC2 supplied to a voltage controlled one shot timer 102. The output of one shot timer 102 then provides AGC pulses that are varying in delay from the pseudo sync pulses' trailing edge on the order of from zero to at least 1.5 μseconds. The output of one shot timer 102 (AGC pulses) is fed to a summing amplifier 104 along with the input video signal. The output of the inverted pseudo sync pulse from AND gate 96 is negatively summed with the output of amplifier 104 via a (negative) summing amplifier 106. The output (e) of amplifier 106 then has position modulated AGC pulses relative to the pseudo sync pulses and is thus a dynamic copy protection signal.

Note Figure 7 illustrates that the AGC pulses also can be pulse width modulated if the one shot timer 84 is voltage controlled. Figures 7a to 7e show the wave forms generated at various locations (a) - (e) in the circuit of Figure 7.

Figures 8a, 8b illustrate that the circuit of Figure 7 can be applied to copy protection pulses with normal sync and raised back porch AGC pulses such as exemplified by Figure 7a. Thus Figure 8b shows a dynamic position modulated copy protection signal that modifies the technique of Figure 3 of Patent 4,819,098. The signal shown in Figure 8b can occur in clusters or in selected video lines.

It should be noted that the copy protection process of the present invention can have position, pulse width and/or gap width modulation, and/or amplitude modulation, done on individual pseudo sync pulses, horizontal sync pulses, AGC pulses or raised back porch AGC pulses, over time from maximum separation (defeated copy protection) to

minimum separation (full copy protection). For instance if there are 40 added pulse pairs of normal pseudo sync pulses and AGC pulses, one can in any combination slowly increase the separation between the AGC pulses and pseudo sync pulses in any number of pulse pair(s) at a time or all of them at a time until sufficient pulse pairs of copy protection pulse pairs have maximum separation to turn off copy protection. Additionally, one can in any combination slowly decrease the separation from maximum separation (defeated copy protection) to minimum separation (full copy protection).

As a further example, copy protection signals can be applied throughout the vertical blanking interval and its vicinity, and the copy protection signals can include different amounts of added pulses per video line. In one embodiment for example, a single pseudo sync pulse and/or AGC pulse in a video line can be modulated. As previously mentioned, the AGC or raised back porch AGC pulses also can be amplitude modulated in combination with the above-mentioned processes.

Figure 9a depicts a waveform of a prior art copy protection signal. Figure 9b depicts a waveform of a defeating or modifying method for the signal of Figure 9a which reverses the order of at least portions of the pseudo sync and/or AGC pulses. Figure 9c is a waveform of another method to defeat or modify the original process (Figure 9a for example) by phase shifting, i.e., inverting, at least portions of the pseudo syncs and/or AGC pulses. In the case of Figure 9c the phase shift is a 180 degree reversal of pseudo syncs and AGC pulses. Note that the methods described for Figures 9b and 9c can be applied to those copy protection pulses around or within the horizontal blanking interval. The methods described for Figures 9b and 9c can of course be combined with relative attenuation, pulse narrowing, level shifting, and/or position modulation copy protection defeating processes.

Also it is possible to use the techniques described for Figures 9b and 9c to synthesize a copy protection signal. To dynamically turn on and off the copy protection process for example, the technique starts with a copy protection signal as shown in Figure 9a (copy protection effectively on). The technique continues for example, by slowly reversing the order of the pseudo syncs with the AGC pulses until the (modified) copy protection signal substantially becomes Figure 9b (copy protection effectively off). Similarly, if the technique starts with Figure 9a where the copy protection is fully on, then the copy protection process is slowly turned off by inverting (phase shifting), attenuating, level shifting and/or position modulating the pseudo syncs and/or AGC pulses until the (modified) copy protection signal becomes the signal depicted in Figure 9c.

Referring to Figure 10, by using a video memory 110 and/or a regenerating signal, the waveform of Figure 9a can be transformed to that of Figure 9b. In this embodiment, the video memory 110 stores for example, the signal of Figure 9a wherein however, the signal is read out of memory in reverse order to achieve the signal of Figure 9b. Thus, the block diagram of Figure 10 is an example of circuitry for implementing the latter signal reversing technique for all or selected portions of the pseudo syncs and/or AGC pulses.

Figure 11 illustrates circuitry for providing the phase shifting technique of previous mention, which transforms the waveform of Figure 9a to that of Figure 9c. To this end, an inverting (or phase shifting) amplifier 112 inverts (phase shifts) the signal of Figure 9a. A video mix dissolve amplifier 114 (or switcher) is used to transform or transition the waveform from that of Figure 9a to that of Figure 9c. The dissolve amplifier 114 is responsive to a control voltage 118. Accordingly, Figure 11 illustrates circuitry for inverting or phase shifting at least portions of the pseudo syncs and/or AGC pulses by way of the inverting or phase shifting amplifier 112 along with the switching or dissolving amplifier 114. An optional level shifting and/or attenuating circuit 116 is also illustrated

in Figure 11 in phantom line. The level shifting/attenuating circuit 116 is responsive to a level shift control signal 120.

Although the invention has been described herein relative to specific embodiments, various additional features and advantages will be apparent from the description and drawings, and thus the scope of the invention is defined by the following claims and their equivalents.

What is claimed is:

1. A method of defeating copy protection signals in one or more selected video lines of a video signal being supplied to a VCR and/or TV set, wherein the copy protection signals include sync and/or pseudo sync and AGC pulses, with the AGC pulses having a given small position separation, including zero separation, from the sync/pseudo sync pulses, comprising:

providing the AGC pulses with the leading edge thereof having the small position separation from the trailing edge of respective sync/pseudo sync pulses wherein the small position separation maintains the copy protection effect; and

shifting the relative position of either the leading edge of the AGC pulses or the trailing edge of the respective sync/pseudo sync pulses with respect to each other to provide a further position separation therebetween sufficient to reduce the effects of the copy protection signals in the VCR and/or TV set and allow the recording of a viewable copy.

2. The method of claim 1 including:

delaying the leading edge of the AGC pulses relative to the trailing edge of the respective sync/pseudo sync pulses by a time period commensurate with said further position separation.

3. The method of claim 2 wherein the delay is about 1.0 to about 2.5 microseconds depending upon the amount of the small position separation, and provides said further position separation of about 1.5 or more microseconds.

4. The method of claim 1 including:

advancing the trailing edge of the sync/pseudo sync pulses relative to the leading edge of the respective AGC pulses by a time period commensurate with said further position separation.

5. The method of claim 4 wherein the advancement is about 1.0 to about 2.5 microseconds depending upon the amount of the small position separation, and provides said further position separation of about 1.5 or more microseconds.

6. The method of claim 1 including:

delaying the AGC pulses by about 0.5 to about 1.5 microseconds relative to respective sync/pseudo sync pulses, while advancing the trailing edge of the sync/pseudo sync pulses about 0.5 to about 1.5 microseconds relative to the delayed respective AGC pulses.

7. The method of claim 1 including:

narrowing the durations of the sync/pseudo sync pulses and/or the AGC pulses in combination with the shifting of the relative positions of the sync/pseudo sync and AGC pulses.

8. The method of claim 1 wherein the video level of said further position separation is at a video level in the region of about blanking level.

9. The method of claim 1 including:

delaying the AGC pulse relative to the sync/pseudo sync pulse to provide said further position separation that almost defeats the copy protection signals; and

narrowing the AGC pulse an amount sufficient to reduce the effects of the copy protection signals.

10. The method of claim 1 including:

advancing the sync/pseudo sync pulse's trailing edge to provide a narrowed sync/pseudo sync signal;

delaying the AGC pulse's leading edge to provide a narrowed AGC pulse; and

wherein the resulting further position separation between the sync/pseudo sync pulses and respective AGC pulses is sufficient to reduce the effects of the copy protection signals.

11. The method of claim 1 including:

delaying the position of the AGC pulse;

advancing the sync/pseudo sync pulse's trailing edge to narrow the sync/pseudo sync pulse; and

wherein the resulting further position separation between the sync/pseudo sync pulses and respective AGC pulses is sufficient to reduce the effects of the copy protection signals.

12. The method of claim 1 including:

removing all or sufficient portions of the copy protection signals of sync/pseudo sync and AGC pulses;

inserting new sync/pseudo sync pulses in advance of the position of the original sync/pseudo sync pulses that are removed; and

inserting new AGC pulses in delayed relation to the position of the original AGC pulses;

thereby providing said further position separation sufficient to reduce the effects of the copy protection signals.

13. The method of claim 1 including:

providing the AGC pulses with the small position separation with respect to respective normal sync pulses; and

position modulating the AGC pulses while maintaining said further position separation between the AGC and normal sync pulses which reduces the effects of the copy protection signals.

14. The method of claim 1 wherein the step of shifting includes:

reversing the order of at least portions of the sync/pseudo sync pulses and respective AGC pulses while maintaining said further position separation.

15. The method of claim 1 wherein the step of shifting includes:

phase shifting at least portions of the sync/pseudo sync and AGC pulses to about 180 degrees.

16. Apparatus for defeating copy protection signals in one or more selected video lines of a video signal being supplied to a VCR and/or TV set, wherein the copy protection signals include sync and/or pseudo sync pulses and AGC pulses, with the AGC pulses having a given small position separation, including zero separation, from the sync and/or pseudo sync pulses, comprising:

input means for supplying the copy protected video signal with the AGC pulses and the respective sync/pseudo sync pulses with the given small position separation which maintains the copy protection effect;

timing circuitry for providing timing signals indicative of one or more video lines containing sync/pseudo sync and AGC pulses; and

circuit means responsive to the timing circuitry for shifting the relative edges and/or positions of the AGC pulses and of the sync/pseudo sync pulses with respect to each other so as to provide a further position separation there between which is of sufficient separation to reduce or defeat the effects of the copy protection signals in the VCR and/or TV set and allow the recording of a viewable copy of the video signal.

17. The apparatus of claim 16 wherein:

the timing circuitry includes sync separating means for providing selected sync signals; and

a timing circuit responsive to the sync separating means for providing the timing signals;

the circuit means include delay means for delaying the copy protected video signal; and

a clipper circuit responsive to the delay means for supplying delayed AGC pulses; and

the apparatus including switching means for inserting the delayed AGC pulses into the copy protected video signal in response to the timing signals.

18. The apparatus of claim 16 wherein:

the timing circuitry includes sync separating means for providing selected sync signals; and

a timing circuit responsive to the sync separating means for providing the timing signals;

the circuit means include multivibrator means responsive to the sync separating means for providing a defeat signal which causes said further position separation; and

logic means responsive to the timing circuit and multivibrator means for providing a control signal indicative of the presence of the copy protection signals and of said further position separation; and

switching means receiving the copy protected video signal for inserting said defeat signal into the video signal in response to the control signal, to modify the widths of the sync/pseudo sync pulses and AGC pulses.

19. The apparatus of claim 18 including:

a chroma filter receiving the copy protected video signal for reinserting color burst into the unprotected video signal via the switching means in response to the control signal, during the modifying of the pulses' widths.

20. The apparatus of claim 16 wherein the copy protection signals include sync/pseudo sync and AGC pulse pairs, wherein:

the timing circuitry includes control means for supplying write and read signals; and

the circuit means include memory means receiving the copy protected video signal in response to the write signal, wherein the stored copy protected video signal is recovered from the memory means in reverse order in response to the read signal to provide reversed pulse pairs having said small position separation between the sync/pseudo sync and AGC pulses which reduces the effect of the copy protection signals.

21. The apparatus of claim 20 wherein the copy protected video signal reversing process is implemented for all or selected portions of the sync/pseudo sync and/or AGC pulses.

22. The apparatus of claim 16 wherein:

the timing circuitry includes a source of control voltage;

the circuit means includes inverting amplifier/phase shifter means receiving the copy protected video signal for providing inverted/phase shifted sync/pseudo sync and AGC signals; and

dissolve amplifier means responsive to the control voltage for replacing the original sync/pseudo sync and AGC pulses with the inverted/phase shifted sync/pseudo sync and AGC pulses.

23. The apparatus of claim 22 including:

a second control voltage;

level shifter/attenuator means receiving the output of the dissolve amplifier means and responsive to the second control voltage for level shifting/attenuating the inverted/phase shifted sync/pseudo sync and AGC pulses.

24. A method of providing copy protection signals in a video signal employing sync or pseudo sync pulses followed by AGC pulses, comprising:

providing the AGC pulses with the leading edges thereof generally coincident with the trailing edges of respective sync/pseudo sync pulses thereby having essentially small to zero position separation consistent with maintaining copy protection;

dynamically increasing over time the position separation between the sync/pseudo sync pulses and the respective AGC pulses so as to reduce or defeat the effects of the copy protection signals; and

dynamically decreasing over time the position separation between the sync/pseudo sync pulses and the respective AGC pulses to return to the essentially small to zero position separation that maintains copy protection.

25. The method of claim 24 including:

dynamically varying the position separation between at least one sync/pseudo sync and at least one respective AGC pulse from the essentially small to zero position separation to a position separation of about 1.5 to about 5.0 microseconds.

26. The method of claim 24 including:

dynamically varying the position separation by dynamically varying the advancement of the trailing edge of the sync/pseudo sync pulses with respect to the respective AGC pulses.

27. The method of claim 24 including:

dynamically varying the position separation by dynamically varying the delay of the leading edge of the AGC pulses with respect to the respective sync/pseudo sync pulses.

28. The method of claim 24 including:

dynamically varying the position separation by dynamically varying the advancement of the sync/pseudo sync pulses while dynamically varying oppositely the delay of the AGC pulses.

29. The method of claim 24 including:

dynamically varying the position separation by dynamically varying the pulse width of the AGC pulses and/or of the sync/pseudo sync pulses.

30. The method of claim 24 including:

dynamically narrowing the pulse width of the AGC pulses and/or the sync/pseudo sync pulses from 100 percent to about 50 percent and back to 100 percent.

31. Apparatus for providing copy protection signals in a video signal employing sync and pseudo sync pulses followed by AGC pulses, comprising:

timing circuitry for providing timing signals indicative of video lines which are to contain the copy protection signals, and of the location in the video lines of selected copy protection signals;

circuit means responsive to the timing circuitry for generating modulated inverted pseudo sync pulses, and for generating AGC pulses that vary in width and position delay in response to the modulated inverted pseudo sync pulses; and

summing means receiving the video signal and responsive to the circuit means and the timing circuitry for adding to the video signal a dynamic copy protection signal formed of position modulated AGC pulses relative to the pseudo sync pulses.

32. The apparatus of claim 31 wherein:

the timing circuitry includes sync separating means for providing a horizontal rate (H rate) signal and a frame rate signal;

means responsive to the H rate signal for providing a first signal which defines a positive pulse duration of an H rate related signal;

multivibrator means responsive to the H rate signal for providing a second signal indicative of the location of sync pulses in a video line;

means responsive to the H rate and frame rate signals for providing a third signal indicative of the video lines which are to contain the copy protection signals; and

logic means responsive to the first, second and third signals for providing inverted pseudo sync pulses on selected video lines;

the circuit means include one shot timer circuit means responsive to control voltages for providing said AGC pulses that are varying in width and in position delay; and

the summing means include summing amplifier means receiving the video signal and responsive to said inverted pseudo sync pulses and said width and position delay varying AGC pulses, for providing the position modulated AGC pulses relative to the pseudo sync pulses, resulting in a dynamically varying copy protected video signal.

33. The apparatus of claim 32 wherein:

said means for providing the first signal include an H locked oscillator;

said means for providing the third signal include a memory means responsive to a line counter;

said one shot timer circuit means include a pair of voltage controlled one shot circuits; and

said summing amplifier means include first and second summing amplifiers responsive to said width and position delay varying AGC pulses and said inverted pseudo sync pulses, respectively.

34. The apparatus of claim 31 wherein:

said circuit means generate the AGC pulses as raised back porch AGC pulses; and

said circuit means dynamically position and/or width modulate the raised back porch AGC pulses over time from minimum to maximum separation and back to minimum separation, with respect to the sync/pseudo sync pulses.

35. The apparatus of claim 31 wherein:

the copy protection signals include sync, pseudo sync, AGC and/or raised back porch AGC pulses; and

said circuit means cause dynamic position, pulse width and/or gap width modulation of the pulses over time from maximum to minimum gap separation.

36. A method of providing copy protection signals in a video signal and for defeating the copy protection signals when desired, wherein the copy protection signals include sync and/or pseudo sync pulses and AGC pulses, comprising:

providing the AGC pulses with the leading edges thereof coincident with, or separated by less than 1.0 microsecond from, the trailing edges of respective sync/pseudo sync pulses to provide the copy protection signals; and

position separating relative

to time the AGC pulses and/or the respective sync/pseudo sync pulses an amount of 1.5 or more microseconds sufficient to defeat the copy protection effect of the copy protection signals.

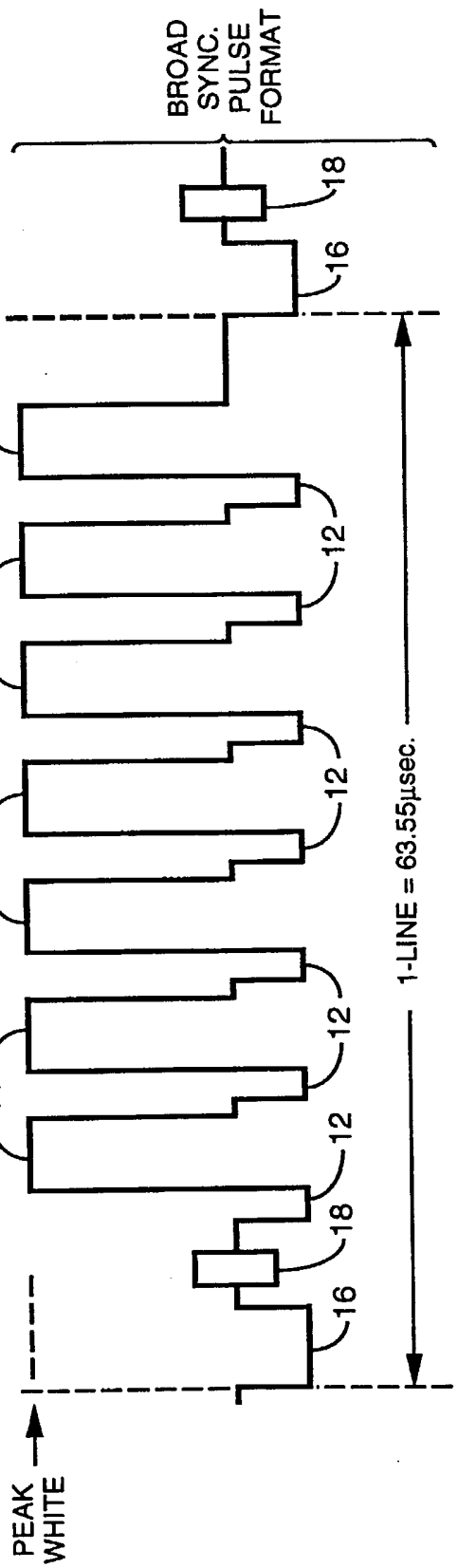


FIG. 1a (PRIOR ART)

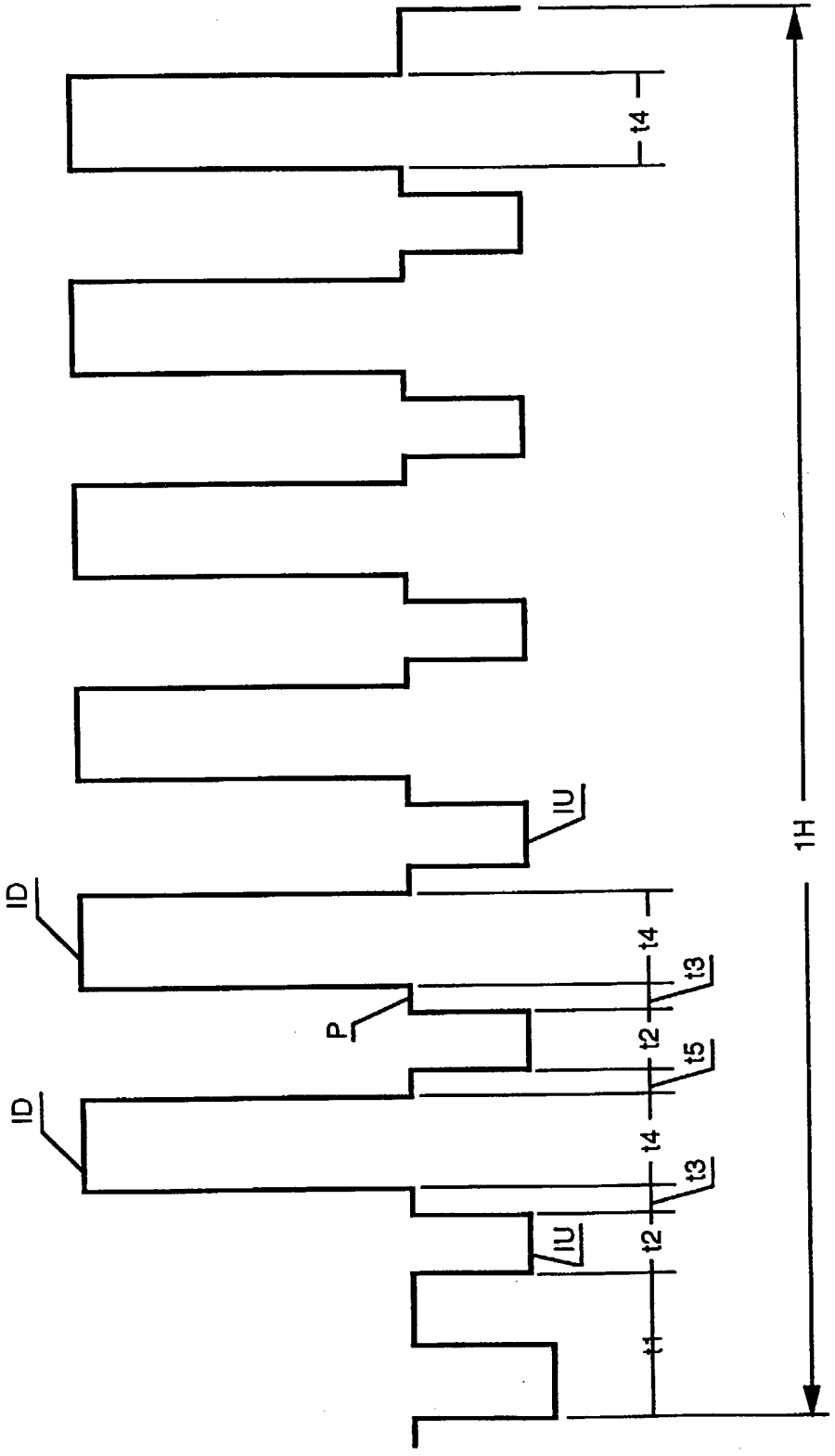


FIG. 1b (PRIOR ART)

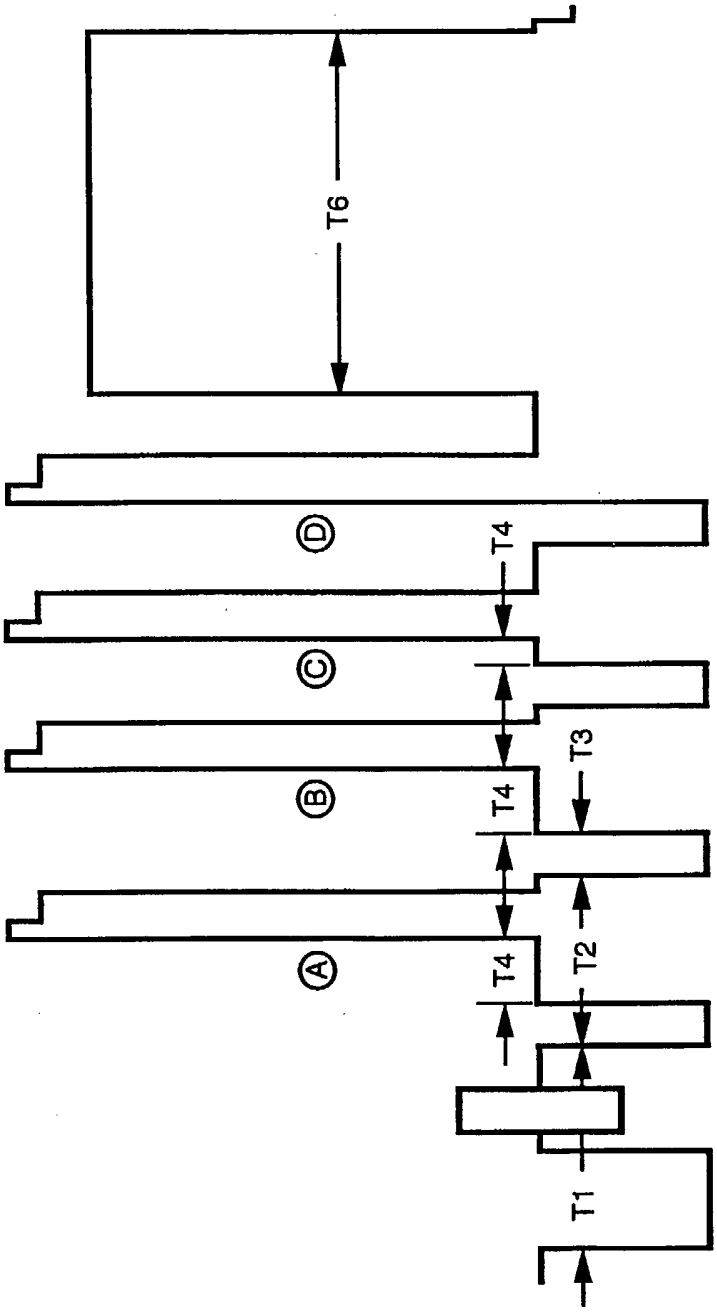


FIG. 2

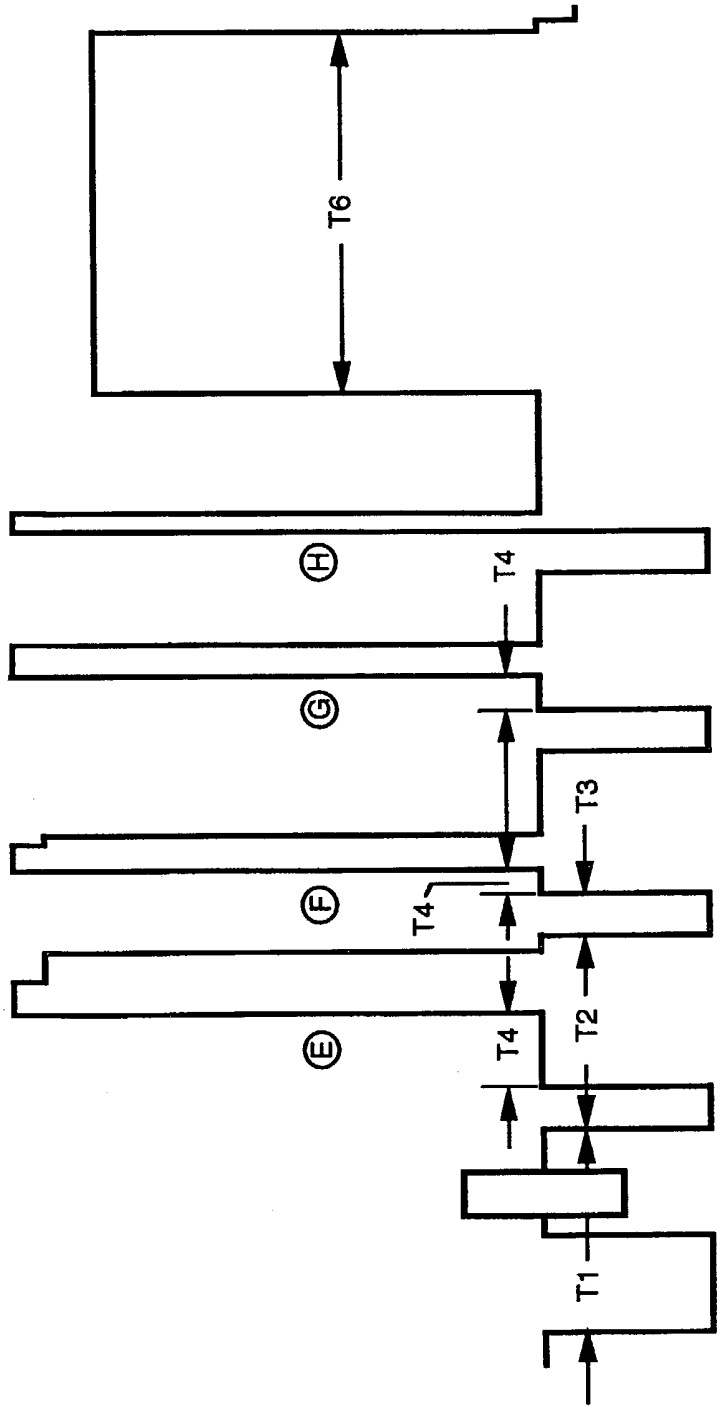


FIG. 3

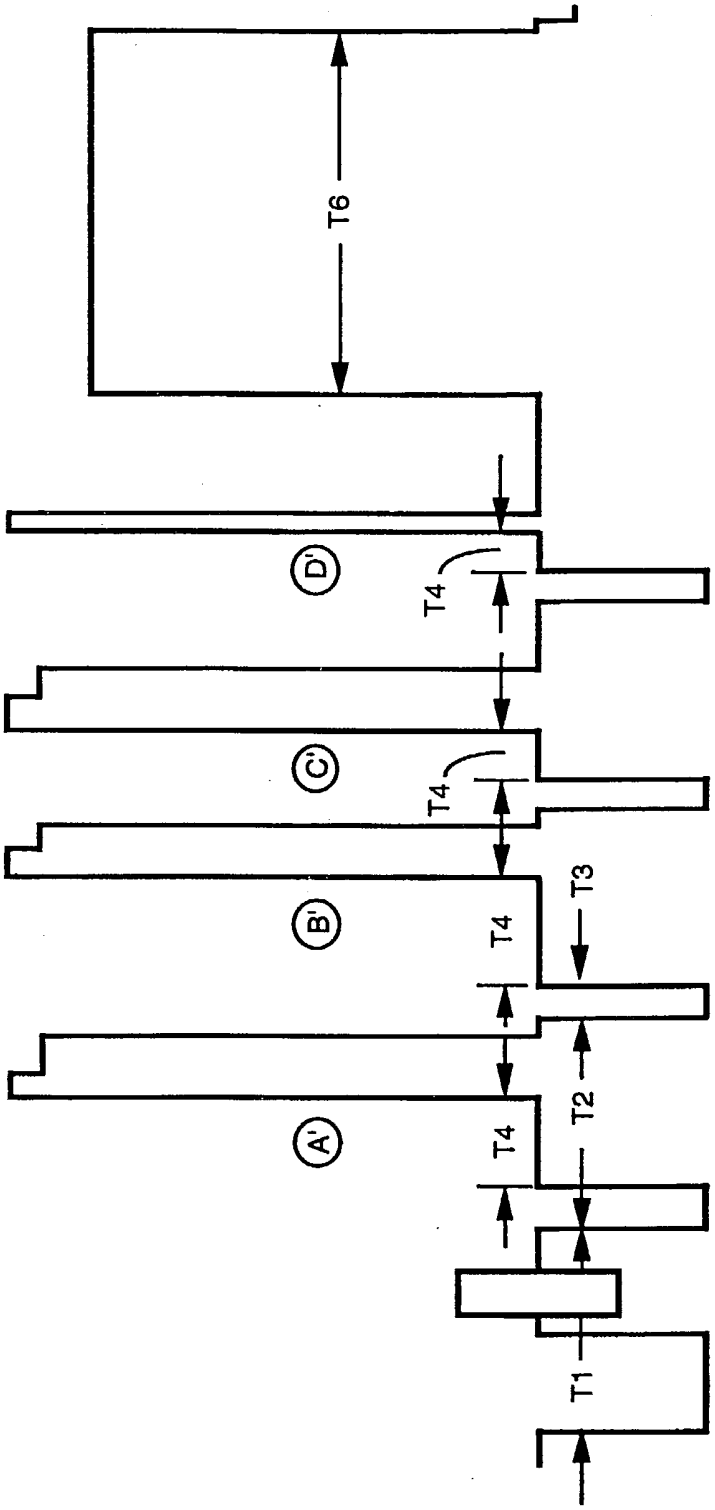


FIG. 4

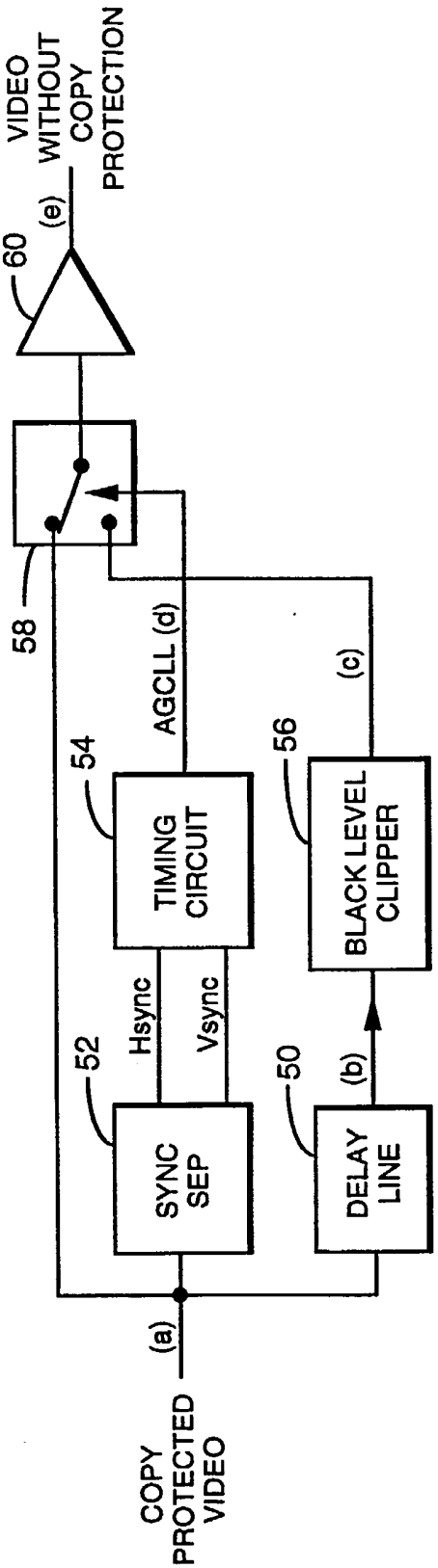

VIDEO WITHOUT COPY PROTECTION
(e)
60
58
AGCLL (d)
(c)
54
56
TIMING CIRCUIT
BLACK LEVEL CLIPPER
Hsync
Vsync
52
50
(b)
SYNC SEP
DELAY LINE
(a)
COPY PROTECTED VIDEO

FIG. 5

FIG. 5a

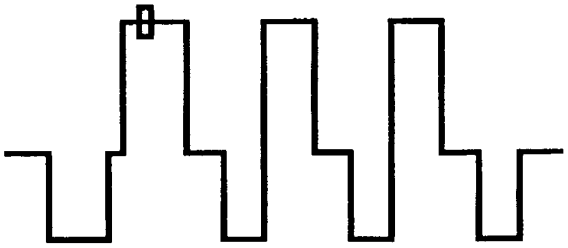


FIG. 5b

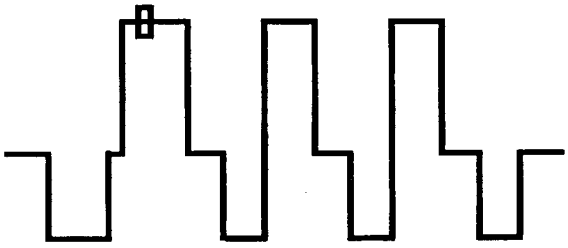


FIG. 5c

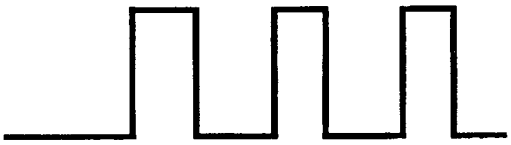
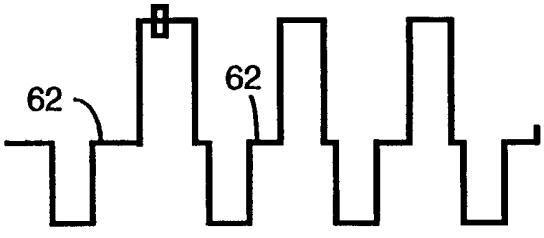


FIG. 5d

FIG. 5e



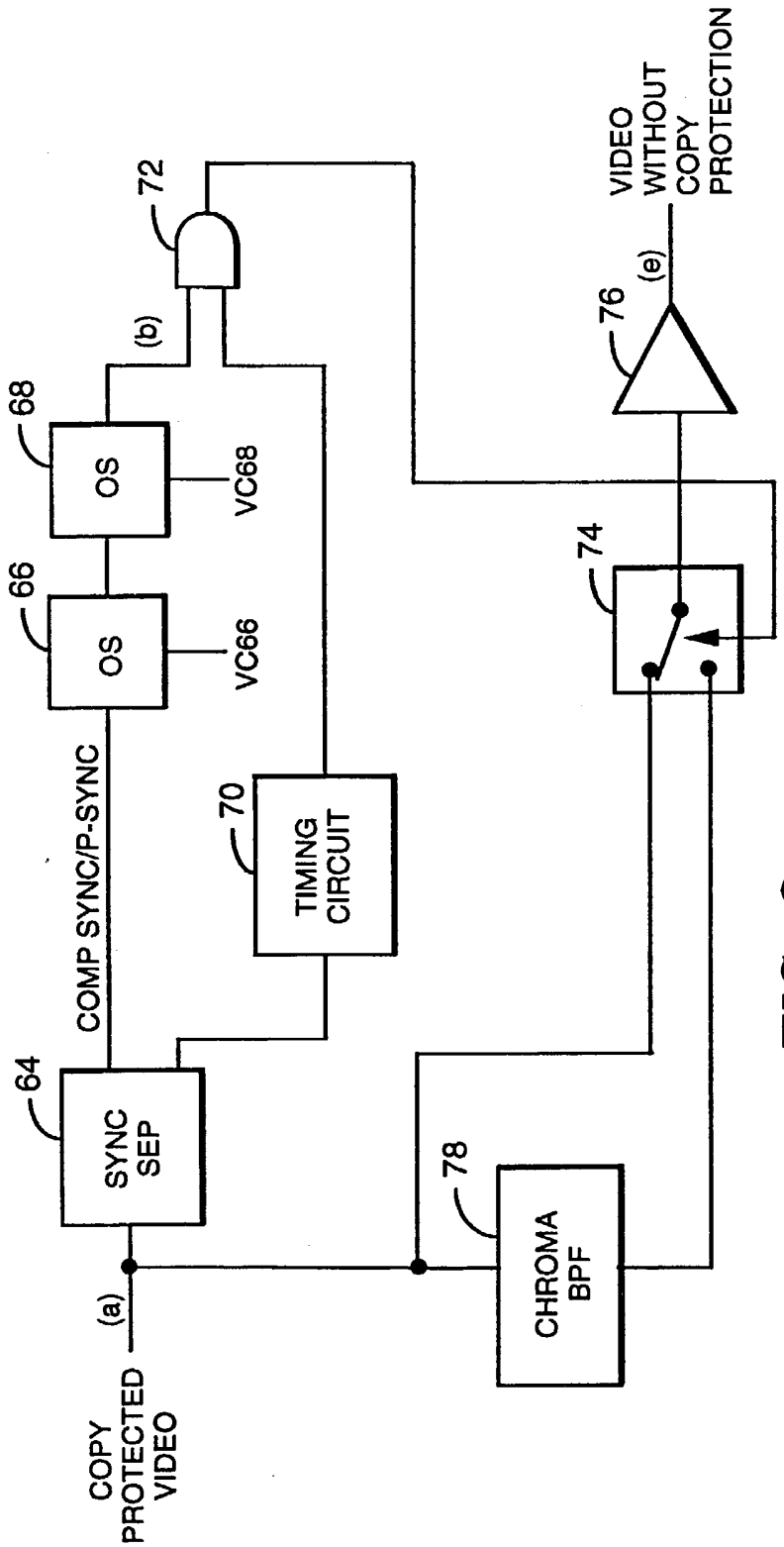

VIDEO WITHOUT COPY PROTECTION
72
(b)
68
OS
VC68
66
OS
VC66
COMP SYNC/P-SYNC
70
TIMING CIRCUIT
64
SYNC SEP
(a)
COPY PROTECTED VIDEO
(e)
76
74
78
CHROMA BPF

FIG. 6

FIG. 6a
(PRIOR ART)

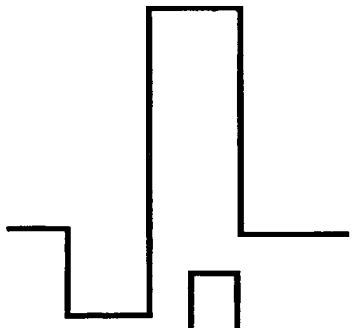


FIG. 6b

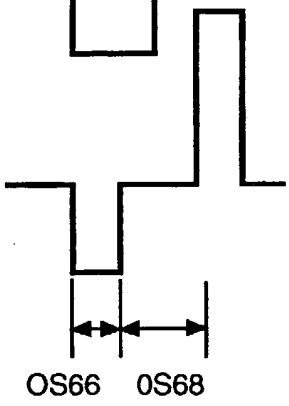


FIG. 6c
(PRIOR ART)

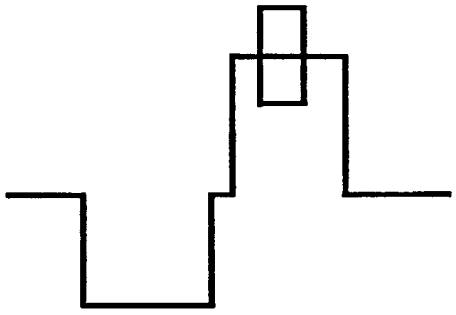


FIG. 6d

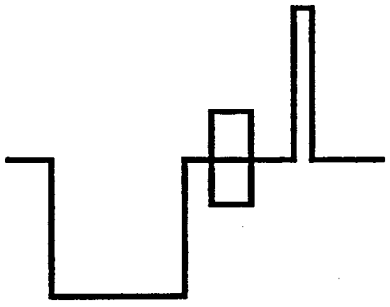
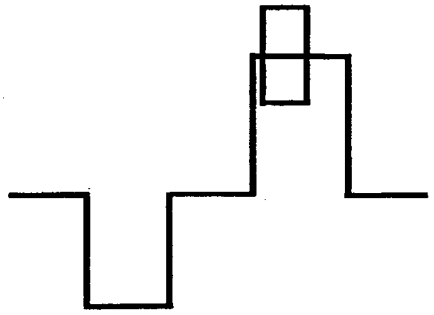


FIG. 6e



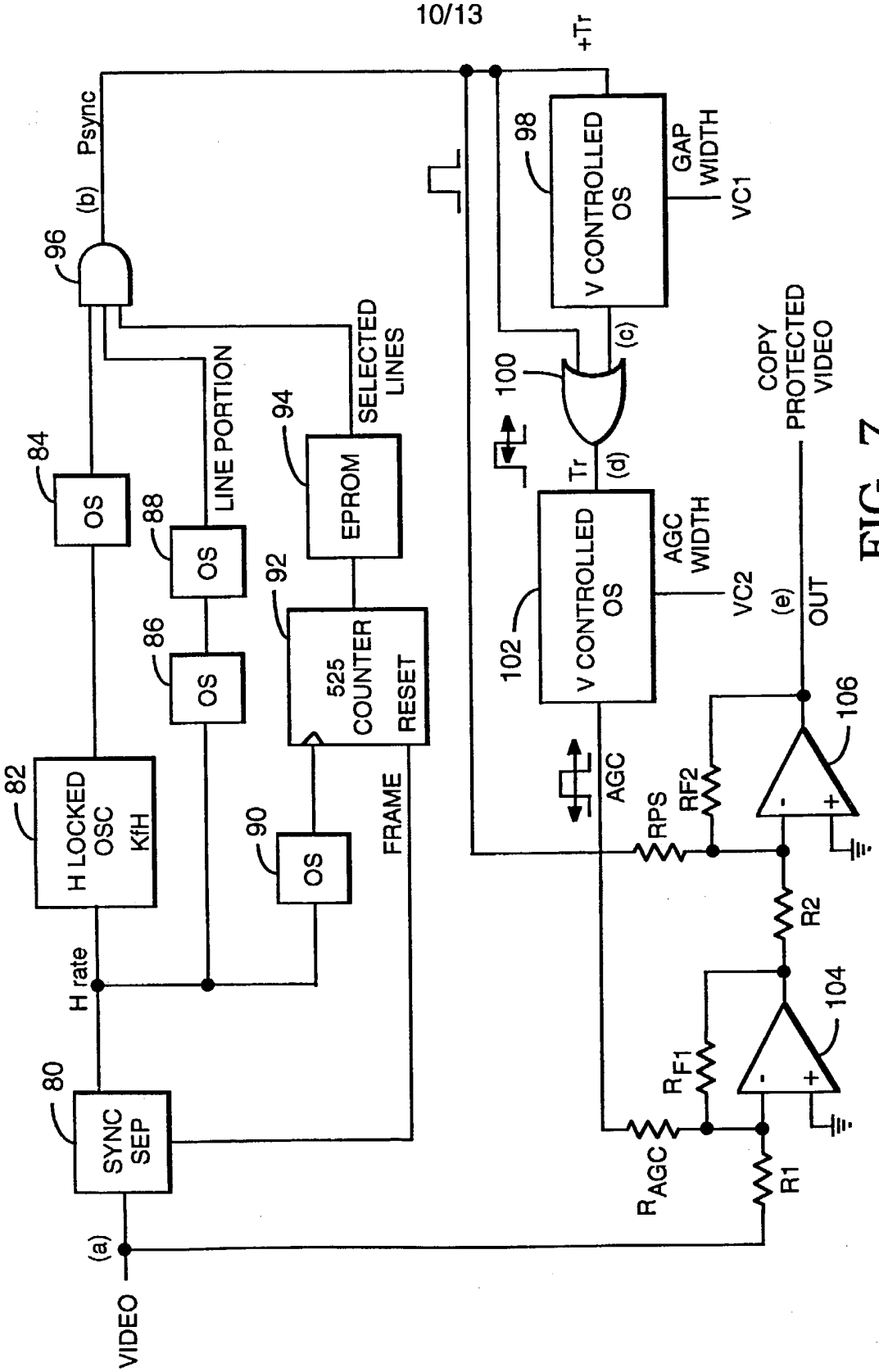

+Tr
Psync
(b)
96
98
V CONTROLLED OS
GAP WIDTH
VC1
SELECTED LINES
94
EPROM
84
OS
88
OS
LINE PORTION
86
OS
92
525 COUNTER RESET
82
H LOCKED OSC KfH
90
OS
FRAME
H rate
80
SYNC SEP
(a)
VIDEO
100
(c)
Tr
(d)
102
V CONTROLLED OS
AGC WIDTH
VC2
AGC
RPS
RF2
106
(e)
OUT
COPY PROTECTED VIDEO
R2
104
RF1
RAGC
R1

FIG. 7

FIG. 7a

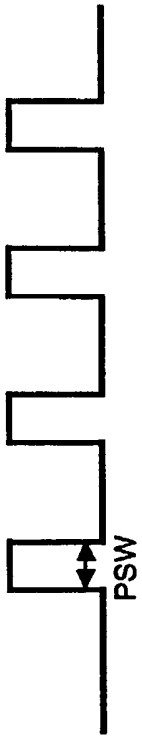


FIG. 7b

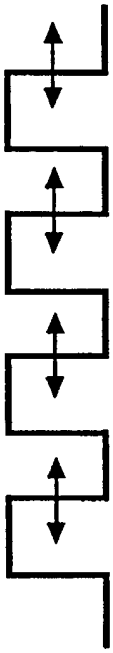


FIG. 7c

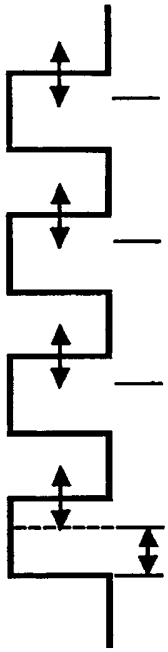


FIG. 7d

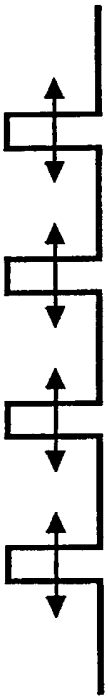


FIG. 7e

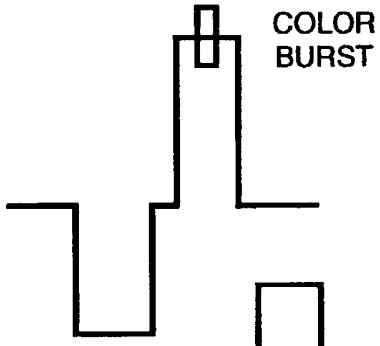


FIG. 8a
(PRIOR ART)

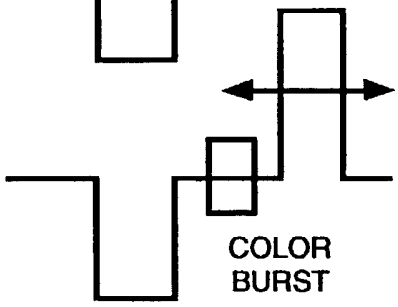


FIG. 8b

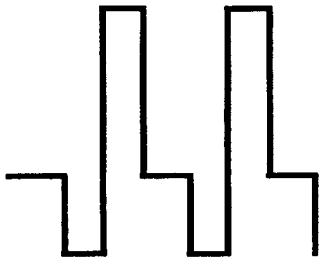


FIG. 9a

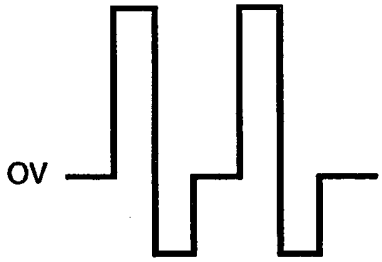


FIG. 9b

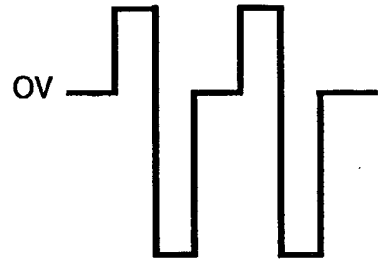


FIG. 9c

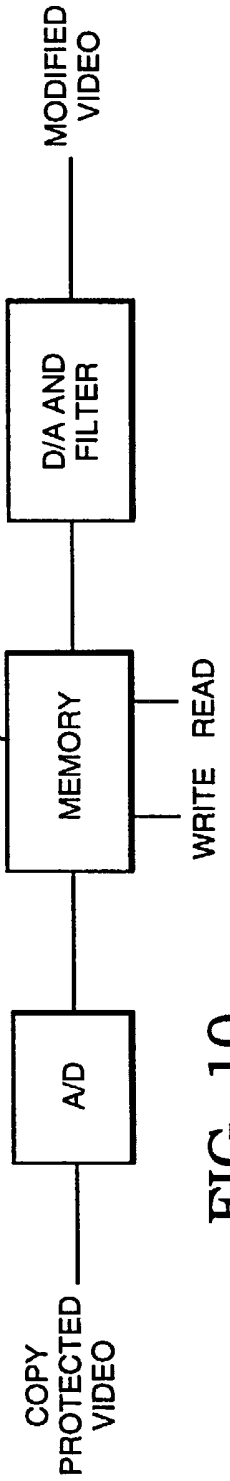

MODIFIED VIDEO
D/A AND FILTER
110
MEMORY
WRITE
READ
A/D
COPY PROTECTED VIDEO

FIG. 10

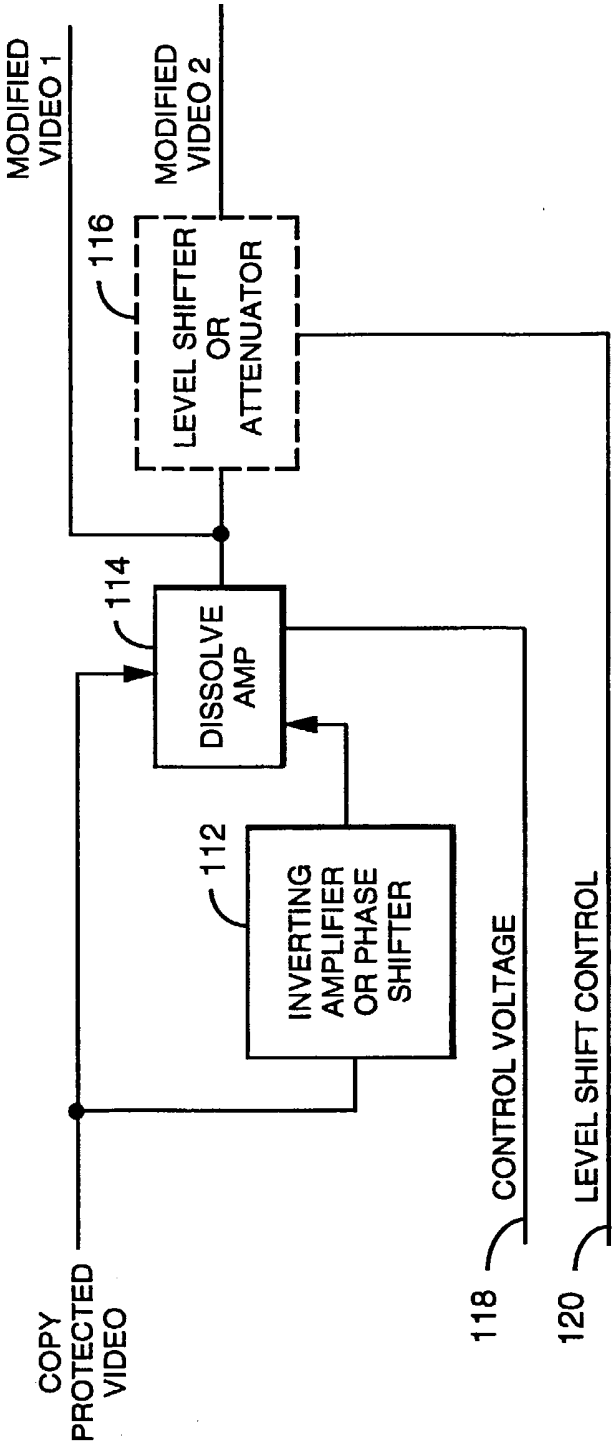

MODIFIED VIDEO 1
MODIFIED VIDEO 2
116
LEVEL SHIFTER OR ATTENUATOR
114
DISSOLVE AMP
112
INVERTING AMPLIFIER OR PHASE SHIFTER
COPY PROTECTED VIDEO
118
CONTROL VOLTAGE
120
LEVEL SHIFT CONTROL

FIG. 11

INTERNATIONAL SEARCH REPORT

Im tional Application No
PCT/US 99/20010

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04N5/913

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 888 649 A (KAGOTA) 19 December 1989 (1989-12-19) the whole document	1,16,24, 31,36
A	WO 97 15142 A (MACROVISION CORPORATION) 24 April 1997 (1997-04-24) the whole document	1,16,24, 31,36

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 December 1999	12/01/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Verleye, J

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int ional Application No
PCT/US 99/20010

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		WO 9716022 A	01-05-1997
		US 5953417 A	14-09-1999